MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

ETM 2046 – ANALOG AND DIGITAL COMMUNICATIONS

(RE and BE)

10 MARCH 2016
9.00 a.m - 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

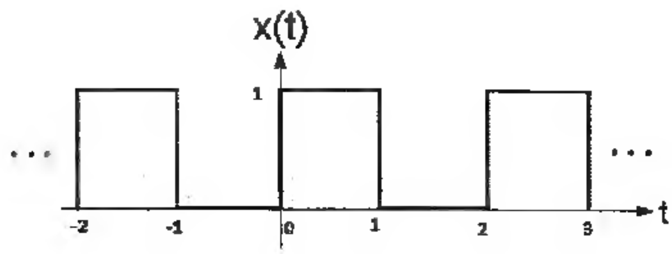
1. This question paper consists of 10 pages excluding cover page with 4 questions only.
2. Answer **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the answer Booklet provided.

Question 1

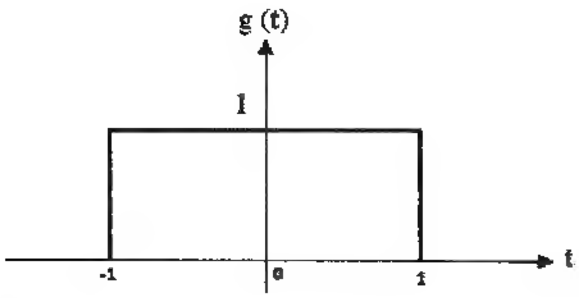
(a) List 2 (TWO) applications using digital communication system. [4 marks]

(b) Name 1(ONE) application that utilize ground wave propagation. [2 marks]

(c) Obtain the Fourier series for the waveform shown below. [10 marks]



(d) Find the Fourier transform for the following gate function. [5 marks]



Hence, deduce the function

(i) $5g(2t)$ [2 marks]

(ii) $\delta g(t)/\delta t$ [2 marks]

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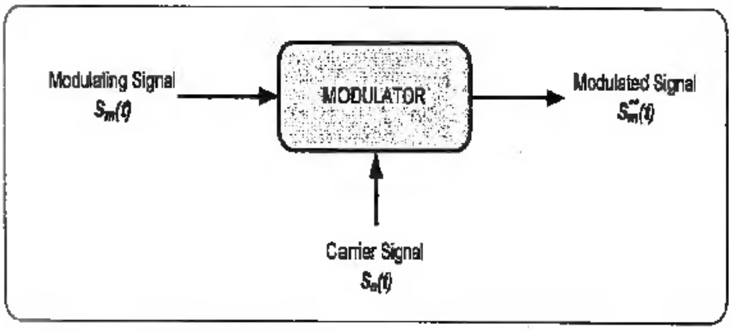
Question 2

(a) Discuss 1(ONE) advantage and 1(ONE) disadvantage of Double Sideband-Suppressed Carrier (DSB-SC) over Double Sideband Large Carrier (DSB-LC). [4 marks]

(b) Given the diagram of Full Amplitude Modulation (DSB-LC) shown below:



AM Modulation Block Diagram

carrier signal given by: $s_c(t) = A_c \cos(2\pi f_c t)$

message signal given by: $s_m(t) = A_m \cos(2\pi f_m t)$

(i) Derive how the modulated signal (DSB-LC) is produced. [3 marks]

(ii) Plot the frequency spectrum of Full AM signal. [2 marks]

(c) An antenna transmits a Full AM signal having a total power content of 15000W and modulation index is 80%. Determine the following:

(i) The carrier power P_c [2 marks]

(ii) Each of the sidebands power P_{USB} and P_{LSB} [2 marks]

(iii) The power efficiency [2 marks]

Continued ....

Question 2

(d) Design an Armstrong indirect FM modulator to generate an FM carrier with a carrier frequency of 98.8MHz and Δf=50kHz. A narrow-band FM generator is available at a carrier frequency of 125kHz and a frequency deviation Δf=10Hz. The stock room also has an oscillator with an adjustable frequency in the range of 10 to 11MHz. There are also plenty of frequency doublers (×2), triplers (×3), and quintuplers(×5).
Show your design with block diagram. [10 marks]

Question 3

(a) In pulse amplitude modulation (PAM), there are two types of practical sampling methods. Figure3.1 below shows an analog signal being sampled at regular time interval.

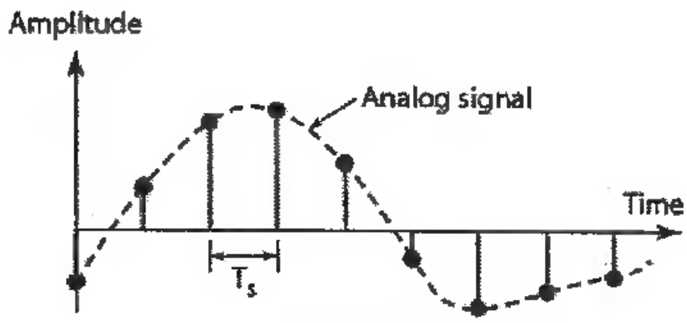


Figure3.1

Sketch the output pulse for the sampling method used.

(i) Natural sampling [2 marks]
(ii) Flat-top sampling [2 marks]

Continued ....

Question 3

(b) A CD audio laser-disk system has sampling frequency of 44.1 kHz.

(i) Determine the maximum audio frequency of the CD audio. [2 marks]

(ii) Justify whether the sampling rate of 44.1 kHz is sufficient for CD audio [2 marks]

(iii) If 16 bits are used for the quantization, calculate how many discrete levels it can produce. [1 mark]

(iv) Calculate the datarate of the audio system. [2 marks]

(v)Determine the possibility to stream this audio quality over the Streamyx bandwidth of 512kbps. Discuss 1(ONE) way to enable such audio streaming over the 512kbps bandwidth internet. [2 marks]

(c) Draw the encoded bits for [1 1 0 1 0 0 1] using the following binary line codes.

(i) Unipolar NRZ [1 mark]

(ii) Polar NRZ [1 mark]

(iii) Unipolar RZ [1 mark]

(iv) Bipolar RZ [1 mark]

(v)Manchester NRZ [1 mark]

(d) A 11.2kbps data terminal is connected to a modem. Calculate the transmission bandwidth required at the modem output for each of the following schemes. 80% roll-off shaping is used in all cases.

(i) Binary ASK [2 marks]

(ii) Binary FSK
Assume that the frequency deviatesΔ4000 Hz about the carrier [2 marks]

(iii) 16-state QAM [3 marks]

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Question 4

(a) A source has 4 symbols [S1, S2, S3, S4], the probability of the symbols are as follows.

P(S1)= 0.5 , P(S2)= 0.3 , P(S3)= 0.15, P(S4)= 0.05

i) Find the information content (in bits) for each of the symbols. [2 marks]

ii) Hence, find the entropy (in bits/symbol) of the source. [2 marks]

iii) Compute the optimum Huffman code in order to obtain the variable length code. Show the binary code for each symbol S1, S2, S3 and S4. [6 marks]

iv) Find the average number of bits per codeword. [2 marks]

v) Compute the efficiency of the Huffman encoding scheme [1 mark]

vi) Find the minimum number of bits per codeword assuming a fixed-length codeword [1 mark]

vii) Find the compression ratio by comparing Huffman coding and the best possible fixed length coding. [1 mark]

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(b) The diagram in Figure 4.1 below shows the generation of a (7,4) Hamming code. P_0,P_1 and P_2 are the parity bit while a, b, c and d are the message bit.

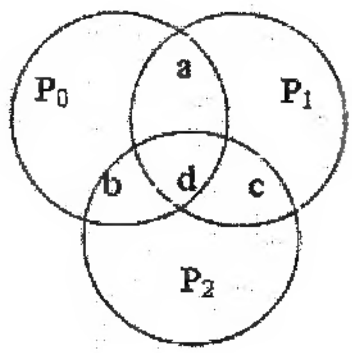

Figure 4.1: Venn Diagram

(i) From Figure 4.1 Venn diagram, determine the generator matric G. [2 marks]

(ii) Calculate the codeword for message [1100] and [1011]. [2 marks]

(iii) From the generator matrix G, find the parity check matrix H and H^T. [3 marks]

(iv) Compute the error syndrome for the received code word of [0111100] and [0111110] [3 marks]

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Appendix I: Fourier Transform Pairs

$x(t)$	$X(f)$
$\delta(t)$	1
$\delta(t-t_o)$	$e^{-j2\pi f t_o}$
1	$\delta(f)$
$e^{j2\pi f_o t}$	$\delta(f-f_o)$
$u(t)$	$\frac{1}{2}\delta(f)+\frac{1}{j2\pi f}$
$e^{-at}u(t)$	$\frac{1}{a+j2\pi f}$, for $a>0$
$e^{at}u(-t)$	$\frac{1}{a-j2\pi f}$, for $a>0$
$e^{-a\|t\|}$	$\frac{2a}{a^2+(2\pi f)^2}$, for $a>0$
$t^n e^{-at}u(t)$	$\frac{n!}{(a+j2\pi f)^{n+1}}$, for $a>0$
$rect\left(\frac{t}{T}\right)$	$T\mathrm{sinc}(fT)$
$\mathrm{sinc}(2Wt)$	$\frac{1}{2W}rect\left(\frac{f}{2W}\right)$
$\Delta\left(\frac{t}{T}\right)$	$\frac{T}{2}\mathrm{sinc}^2\left(\frac{fT}{2}\right)$
$W\mathrm{sinc}^2(Wt)$	$\Delta\left(\frac{f}{2W}\right)$
$e^{-\pi t^2}$	$e^{-\pi f^2}$

Continued …….

$\cos(2\pi f_o t)$	$\frac{1}{2}\delta(f-f_o)+\frac{1}{2}\delta(f+f_o)$
$\sin(2\pi f_o t)$	$\frac{1}{2j}[\delta(f-f_o)-\delta(f+f_o)]$
$\operatorname{sgn}(t)=\begin{cases}1 & t>0\\ -1 & t<0\end{cases}$	$\frac{1}{j\pi f}$
$\frac{1}{\pi t}$	$-j\operatorname{sgn}(f)$
$\sum_{i=-\infty}^{\infty}\delta(t-iT_o)$	$\frac{1}{T_o}\sum_{n=-\infty}^{\infty}\delta(f-\frac{n}{T_o})$
$e^{-at}\cos(2\pi f_o t)u(t)$	$\frac{a+j2\pi f}{(a+j2\pi f)^2+(2\pi f_o)^2}$, for $a>0$
$e^{-at}\sin(2\pi f_o t)u(t)$	$\frac{2\pi f_o}{(a+j2\pi f)^2+(2\pi f_o)^2}$, for $a>0$

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Appendix II: Fourier Transform Properties

Let $x(t) \Leftrightarrow X(f)$, $x_1(t) \Leftrightarrow X_1(f)$ and $x_2(t) \Leftrightarrow X_2(f)$; and a, b, t_o and f_o scalar quantities.	
Linearity	$ax_1(t)+bx_2(t) \Leftrightarrow aX_1(f)+bX_2(f)$
Conjugation	$x^*(t) \Leftrightarrow X^*(-f)$
Duality	$X(t) \Leftrightarrow x(-f)$
Scaling ($a \neq 0$)	$x(at) \Leftrightarrow \frac{1}{\lvert a \rvert} X\left(\frac{f}{a}\right)$
Time Shifting	$x(t-t_o) \Leftrightarrow X(f)e^{-j2\pi f t_o}$
Frequency Shifting	$x(t)e^{j2\pi f_o t} \Leftrightarrow X(f-f_o)$
Modulation	$x(t)\cos(2\pi f_0 t) \Leftrightarrow \frac{1}{2}X(f-f_0)+\frac{1}{2}X(f+f_0)$

Time Convolution	$x_1(t) * x_2(t) \Leftrightarrow X_1(f)X_2(f)$
Frequency Convolution	$x_1(t)x_2(t) \Leftrightarrow X_1(f) * X_2(f)$
Time Differentiation	$\frac{d^n}{dt^n}x(t) \Leftrightarrow (j2\pi f)^n X(f)$
Frequency Differentiation	$(-jt)^n x(t) \Leftrightarrow \frac{d^n}{df^n}X(f)$
Time Integration	$\int_{-\infty}^{t} x(\tilde{t})d\tilde{t} \Leftrightarrow \frac{X(f)}{j2\pi f}+\frac{1}{2}X(0)\delta(f)$
Frequency Integration	$x(t)u(t) \Leftrightarrow \int_{-\infty}^{f} X(\tilde{f})d\tilde{f}$

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Appendix III: Table of Bessel Function

n	$\beta = 0$	$\beta = 0.05$	$\beta = 0.1$	$\beta = 0.2$	$\beta = 0.3$	$\beta = 0.5$	$\beta = 0.7$	$\beta = 1$	$\beta = 2$	$\beta = 3$	$\beta = 5$	$\beta = 7$	$\beta = 8$	$\beta = 10$
0	1.000	0.999	0.998	0.990	0.978	0.938	0.881	0.765	0.224	-0.260	-0.178	0.300	0.172	-0.246
1		0.025	0.050	0.100	0.148	0.242	0.329	0.440	0.577	0.339	-0.328	-0.005	0.235	0.043
2			0.001	0.005	0.011	0.031	0.059	0.115	0.353	0.486	0.047	-0.301	-0.113	0.255
3					0.001	0.003	0.007	0.020	0.129	0.309	0.365	-0.168	-0.291	0.058
4							0.001	0.002	0.034	0.132	0.391	0.158	-0.105	-0.220
5									0.007	0.043	0.261	0.348	0.186	-0.234
6									0.001	0.011	0.131	0.339	0.338	-0.014
7										0.003	0.053	0.234	0.321	0.217
8											0.018	0.128	0.223	0.318
9											0.006	0.059	0.126	0.292
10											0.001	0.024	0.061	0.207
11												0.008	0.026	0.123
12												0.003	0.010	0.063
13												0.001	0.003	0.029
14													0.001	0.012
15														0.005
16														0.002
17														0.001

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